

WHAT IS CLAIMED IS:

1. A telecommunications system, comprising:  
a transmitter having an encoder that implements a multi-state trellis code; and  
at least two transmission elements coupled to the transmitter,  
wherein, during operation, the encoder:  
receives a group of input data bits,  
selects a particular space-time block code from a set of space-time block codes, based on the group of input bits and a state of the encoder,  
selects at least two modulation symbols, one symbol for each of the at least two transmission elements, based on the group of input bits and the state of the encoder, and  
encodes the group of input data bits, using the particular space-time block code and the at least two modulation symbols, for transmission by the at least two transmission elements.
2. The system of claim 1, wherein  
the at least two transmission elements are antennas.
3. The system of claim 1, wherein  
the at least two transmission elements are optical transmitters.
4. The system of claim 1, wherein  
the coding gain distance of the multi-state trellis code is maximized.

5. The system of claim 1, wherein  
the at least two transmission elements consists of a first and  
second transmission element, and  
the particular space-time block code is an orthogonal space-time  
block code of a form

$$C(x_1, x_2, \theta) = \begin{pmatrix} x_1 e^{j\theta} & x_2 \\ -x_2^* e^{j\theta} & x_1^* \end{pmatrix}.$$

6. The system of claim 1, wherein  
the at least two transmission elements consists of a first and  
second transmission element, and  
the particular space-time block code is an orthogonal space-time  
block code of a form

$$C(x_1, x_2, \theta) = \begin{pmatrix} x_1 e^{j\theta} & x_2 e^{j\theta} \\ -x_2^* & x_1^* \end{pmatrix}.$$

7. The system of claim 5, wherein  
at least two states of the multi-state trellis code use different  
values of  $\theta$ .
8. The system of claim 7, wherein  
the encoder determines three variables  $X_1$ ,  $X_2$ , and  $\Theta$  based on the  
group of input data bits and the state of the encoder,  
the encoder sends signal  $X_1 e^{j\Theta}$  to the first transmission element and  
signal  $X_2$  to the second transmission element at a time  $T_1$ , and

the encoder sends signal  $-X_2^* e^{j\Theta}$  to the first transmission element and signal  $X_1^*$  to the second transmission element at a time  $T_2$ .

9. The system of claim 8, wherein  
the encoder implements a two-state trellis code.
10. The system of claim 9, wherein  
space-time block code  $C(X_1, X_2, 0)$  is associated with state 1, and  
space-time block code  $C(X_1, X_2, \pi)$  is associated with state 2.
11. The system of claim 10, wherein  
the encoder receives one state bit ( $B_A$ ) and one modulation bit ( $B_B$ )  
at a time  $T_0$ , and  
the transmission variables ( $X_1, X_2, \Theta$ ) equal:  
(0, 0, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and modulation bit ( $B_B$ ) equals 0,  
(1, 1, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and modulation bit ( $B_B$ ) equals 1,  
(0, 1,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 0, and  
(1, 0,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 1.
12. The system of claim 10, wherein  
the encoder receives one state bit ( $B_A$ ) and one modulation bit ( $B_B$ )  
at a time  $T_0$ , and  
the transmission variables ( $X_1, X_2, \Theta$ ) equal:  
(0, 0, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 0,

(1, 1, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 1,

(0, 1,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 0,  
and modulation bit ( $B_B$ ) equals 0, and

(1, 0,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 0,  
and modulation bit ( $B_B$ ) equals 1.

13. The system of claim 10, wherein

the encoder receives one state bit ( $B_A$ ) and three modulation bits  
( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 0, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals  
0, and the modulation bits ( $B_B$ ) equal 000,

(2, 2, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals  
0, and the modulation bits ( $B_B$ ) equal 001,

(0, 2, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals  
0, and the modulation bits ( $B_B$ ) equal 010,

(2, 0, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals  
0, and the modulation bits ( $B_B$ ) equal 011,

(1, 1, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals  
0, and the modulation bits ( $B_B$ ) equal 100,

(3, 3, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals  
0, and the modulation bits ( $B_B$ ) equal 101,

(1, 3, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals  
0, and modulation bits ( $B_B$ ) equal 110,

(3, 1, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals  
0, and the modulation bits ( $B_B$ ) equal 111,

(0, 1,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals  
1, and the modulation bits ( $B_B$ ) equal 000,

(2, 3,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 001,

(0, 3,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and modulation bits ( $B_B$ ) equal 010,

(2, 1,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and modulation bits ( $B_B$ ) equal 011,

(1, 0,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and modulation bits ( $B_B$ ) equal 100,

(3, 2,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and modulation bits ( $B_B$ ) equal 101,

(1, 2,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and modulation bits ( $B_B$ ) equal 110, and

(3, 0,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and modulation bits ( $B_B$ ) equals 111.

14. The system of claim 10, wherein

the encoder receives one state bit ( $B_A$ ) and three modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 1, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 000,

(2, 3, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 001,

(0, 3, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 010,

(2, 1, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 011,

(1, 0, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 100,

(3, 2, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 101,

(1, 2, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and modulation bits ( $B_B$ ) equal 110,

(3, 0, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 111,

(0, 0,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 000,

(2, 2,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 001,

(0, 2,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and modulation bits ( $B_B$ ) equal 010,

(2, 0,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and modulation bits ( $B_B$ ) equal 011,

(1, 1,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and modulation bits ( $B_B$ ) equal 100,

(3, 3,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and modulation bits ( $B_B$ ) equal 101,

(1, 3,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and modulation bits ( $B_B$ ) equal 110, and

(3, 1,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and modulation bits ( $B_B$ ) equals 111.

15. The system of claim 8, wherein  
the encoder implements a four-state trellis code.

16. The system of claim 15, wherein  
space-time block code  $C(X_1, X_2, 0)$  is associated with state 1,  
space-time block code  $C(X_1, X_2, \pi)$  is associated with state 2,  
space-time block code  $C(X_1, X_2, 0)$  is associated with state 3, and

space-time block code  $C(X_1, X_2, \pi)$  is associated with state 4.

17. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and one modulation bit ( $B_B$ )  
at a time  $T_0$ , and  
the transmission variables ( $X_1, X_2, \Theta$ ) equal:
- (0, 0, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and modulation bit ( $B_B$ ) equals 0,
  - (1, 1, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and modulation bit ( $B_B$ ) equals 1,
  - (0, 1,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 0, and
  - (1, 0,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 1.

18. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and one modulation bit ( $B_B$ )  
at a time  $T_0$ , and  
the transmission variables ( $X_1, X_2, \Theta$ ) equal:
- (0, 0, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0,  
and modulation bit ( $B_B$ ) equals 0,
  - (1, 1, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0,  
and modulation bit ( $B_B$ ) equals 1,
  - (0, 1,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 0, and
  - (1, 0,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 1.

19. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and one modulation bit ( $B_B$ )  
at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 0,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals  
0, and modulation bit ( $B_B$ ) equals 0,

(1, 1,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals  
0, and modulation bit ( $B_B$ ) equals 1,

(0, 1, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 0, and

(1, 0, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 1.

20. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and one modulation bit ( $B_B$ )  
at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 0,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals  
0, and modulation bit ( $B_B$ ) equals 0,

(1, 1,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals  
0, and modulation bit ( $B_B$ ) equals 1,

(0, 1, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 0, and

(1, 0, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and modulation bit ( $B_B$ ) equals 1.

21. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and three modulation bits  
( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:



(0, 0, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 000,

(2, 2, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 001,

(0, 2, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 010,

(2, 0, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 011,

(1, 1, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 100,

(3, 3, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 101,

(1, 3, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 110,

(3, 1, 0) if the encoder is in state 1, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 111,

(0, 1,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 000,

(2, 3,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 001,

(0, 3,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 010,

(2, 1,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 011,

(1, 0,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 100,

(3, 2,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 101,

(1, 2,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 110, and

(3, 0,  $\pi$ ) if the encoder is in state 1, state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 111.

22. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and three modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 0, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 000,

(2, 2, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 001,

(0, 2, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 010,

(2, 0, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 011,

(1, 1, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 100,

(3, 3, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 101,

(1, 3, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 110,

(3, 1, 0) if the encoder is in state 2, state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 111,

(0, 1,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 000,

(2, 3,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 001,

(0, 3,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 010,

(2, 1,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 011,

(1, 0,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 100,

(3, 2,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 101,

(1, 2,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 110, and

(3, 0,  $\pi$ ) if the encoder is in state 2, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 111.

23. The system of claim 16, wherein

the encoder receives one state bit ( $B_A$ ) and three modulation bits  
( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 1, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 000,

(2, 3, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 001,

(0, 3, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 010,

(2, 1, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 011,

(1, 0, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 100,

(3, 2, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 101,

(1, 2, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 110,

(3, 0, 0) if the encoder is in state 3, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 111,

(0, 0,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 000,

(2, 2,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 001,

(0, 2,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 010,

(2, 0,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 011,

(1, 1,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 100,

(3, 3,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 101,

(1, 3,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 110, and

(3, 1,  $\pi$ ) if the encoder is in state 3, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 111.

24. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and three modulation bits  
( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 1, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 000,

(2, 3, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 001,

(0, 3, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 010,

(2, 1, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 011,

(1, 0, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 100,

(3, 2, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 101,

(1, 2, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 110,

(3, 0, 0) if the encoder is in state 4, state bit ( $B_A$ ) equals 1,  
and the modulation bits ( $B_B$ ) equal 111,

(0, 0,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 000,

(2, 2,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 001,

(0, 2,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 010,

(2, 0,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 011,

(1, 1,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 100,

(3, 3,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 101,

(1, 3,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 110, and

(3, 1,  $\pi$ ) if the encoder is in state 4, state bit ( $B_A$ ) equals 0,  
and the modulation bits ( $B_B$ ) equal 111.

25. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and four modulation bits  
( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1, X_2, \Theta$ ) equal:

(0, 0, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4, 0) if the encoder is in state 1, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 1,  $\pi$ ) if the encoder is in state 1, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1111.

26. The system of claim 16, wherein

the encoder receives one state bit ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 0, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2, 0) if the encoder is in state 2, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1000,



(7, 3,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_R$ ) equal 0111,

(1, 3,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 1,  $\pi$ ) if the encoder is in state 2, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1111.

27. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(1, 1, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1110,

(7, 1, 0) if the encoder is in state 3, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1110, and

(6, 4,  $\pi$ ) if the encoder is in state 3, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1111.

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28. The system of claim 16, wherein  
the encoder receives one state bit ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and  
the transmission variables ( $X_1, X_2, \Theta$ ) equal:
- (1, 1, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0000,
  - (5, 5, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0001,
  - (1, 5, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0010,
  - (5, 1, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0011,
  - (3, 3, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0100,
  - (7, 7, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0101,
  - (3, 7, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0110,
  - (7, 3, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 0111,
  - (1, 3, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1000,
  - (5, 7, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1001,
  - (1, 7, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1010,
  - (5, 3, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1011,
  - (3, 1, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1110,

(7, 1, 0) if the encoder is in state 4, the state bit ( $B_A$ ) equals 0, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1110, and

(6, 4,  $\pi$ ) if the encoder is in state 4, the state bit ( $B_A$ ) equals 1, and the modulation bits ( $B_B$ ) equal 1111.

29. The system of claim 15, wherein  
space-time block code  $C(X_1, X_2, 0)$  is associated with state 1,  
space-time block code  $C(X_1, X_2, \pi/2)$  is associated with state 2,  
space-time block code  $C(X_1, X_2, \pi)$  is associated with state 3, and  
space-time block code  $C(X_1, X_2, 3\pi/2)$  is associated with state 4.

30. The system of claim 29, wherein  
the encoder receives two state bits ( $B_A$ ) and three modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1, X_2, \Theta$ ) equal:

(0, 1, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,

(4, 5, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,

(0, 5, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,

(4, 1, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,

(2, 3, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,

(6, 7, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,

(2, 7, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,

(6, 3, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,

(0, 3, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,

(4, 7, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,

(0, 7, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,

(4, 3, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,

(2, 1, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,



(3, 2,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

(7, 6,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110,

(7, 0,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $3\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $3\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(7, 1,  $3\pi/2$ ) if the encoder is in state 1, the state bits ( $\mathbf{B}_A$ ) equal 01, and the modulation bits ( $\mathbf{B}_R$ ) equal 1111.

31. The system of claim 29, wherein  
the encoder receives two state bits ( $B_A$ ) and three modulation bits ( $B_B$ ) at a time  $T_0$ , and  
the transmission variables ( $X_1, X_2, \Theta$ ) equal:
- (0, 1, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,
  - (4, 5, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,
  - (0, 5, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,
  - (4, 1, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,
  - (2, 3, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,
  - (6, 7, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,
  - (2, 7, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,
  - (6, 3, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,
  - (0, 3, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,
  - (4, 7, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,
  - (0, 7, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,
  - (4, 3, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,
  - (2, 1, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,

(3, 2,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

(7, 6,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110,

(7, 0,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(5, 7,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 1,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111.

32. The system of claim 29, wherein  
the encoder receives two state bits ( $B_A$ ) and three modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 1, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,

(4, 5, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,

(0, 5, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,

(4, 1, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,

(2, 3, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,

(6, 7, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,



(2, 7, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,

(6, 3, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,

(0, 3, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,

(4, 7, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,

(0, 7, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,

(4, 3, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,

(2, 1, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,

(3, 2,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

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(7, 6,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110,

(7, 0,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(1, 5,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_R$ ) equal 0010,

(5, 1,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 1,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111.

33. The system of claim 29, wherein

the encoder receives two state bits ( $B_A$ ) and three modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 1, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,

(4, 5, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,

(0, 5, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,

(4, 1, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,

(2, 3, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,

(6, 7, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,

(2, 7, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,

(6, 3, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,

(0, 3, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,

(4, 7, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,

(0, 7, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,

(4, 3, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,

(2, 1, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,

(3, 2,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

(7, 6,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110,

(7, 0,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,



(5, 3,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 1,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111.

34. The system of claim 8, wherein  
the encoder implements an eight-state trellis code.

35. The system of claim 34, wherein  
space-time block code  $C(X_1, X_2, 0)$  is associated with state 1,  
space-time block code  $C(X_1, X_2, \pi/2)$  is associated with state 2,  
space-time block code  $C(X_1, X_2, \pi)$  is associated with state 3,  
space-time block code  $C(X_1, X_2, 3\pi/2)$  is associated with state 4,  
space-time block code  $C(X_1, X_2, 0)$  is associated with state 5,  
space-time block code  $C(X_1, X_2, \pi/2)$  is associated with state 6,  
space-time block code  $C(X_1, X_2, \pi)$  is associated with state 7, and  
space-time block code  $C(X_1, X_2, 3\pi/2)$  is associated with state 8.

36. The system of claim 35, wherein  
the encoder receives two state bits ( $B_A$ ) and four modulation bits  
( $B_B$ ) at a time  $T_0$ , and  
the transmission variables ( $X_1, X_2, \Theta$ ) equal:  
(0, 0, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal  
00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4, 0) if the encoder is in state 1, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0010,

(3, 1,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110,

(7, 1,  $\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111,

(0, 1,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,

(4, 5,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,

(0, 5,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,

(4, 1,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,

(2, 3,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,

(6, 7,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,

(2, 7,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,

(6, 3,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,

(0, 3,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,

(4, 7,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,

(0, 7,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,

(4, 3,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,

(2, 1,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5,  $\pi$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(3, 0,  $3\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_R$ ) equal 1100,

(7, 4,  $3\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $3\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 0,  $3\pi/2$ ) if the encoder is in state 1, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111.

37. The system of claim 35, wherein

the encoder receives two state bits ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 0, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4, 0) if the encoder is in state 2, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110,

(7, 1,  $\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111,

(0, 1,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,

(4, 5,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,

(0, 5,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,

(4, 1,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,

(2, 3,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,

(6, 7,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,

(2, 7,  $\pi$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,



(7, 6,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_R$ ) equal 0101,

(3, 6,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(3, 6,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 0,  $3\pi/2$ ) if the encoder is in state 2, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111.

38. The system of claim 35, wherein

the encoder receives two state bits ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 0, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4, 0) if the encoder is in state 3, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110,

(7, 1,  $\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111,

(0, 1,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,

(4, 5,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,

(0, 5,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,

(4, 1,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,

(2, 3,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,

(6, 7,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,

(2, 7,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,

(6, 3,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,

(0, 3,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,

(4, 7,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,

(0, 7,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,

(4, 3,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,

(2, 1,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1,  $\pi$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,

(3, 2,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

(7, 6,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 0,  $3\pi/2$ ) if the encoder is in state 3, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111.

39. The system of claim 35, wherein

the encoder receives two state bits ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 0, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4, 0) if the encoder is in state 4, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,



(5, 7,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110,

(7, 1,  $\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111,

(0, 1,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,

(4, 5,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,

(0, 5,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,

(4, 1,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,

(2, 3,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,

(6, 7,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,

(2, 7,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,

(6, 3,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,

(0, 3,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,

(4, 7,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,

(0, 7,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,

(4, 3,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,

(2, 1,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1,  $\pi$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,

(3, 2,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

(7, 6,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110, and3\

(7, 0,  $3\pi/2$ ) if the encoder is in state 4, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111.

40. The system of claim 35, wherein

the encoder receives two state bits ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 1, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,

(4, 5, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,

(0, 5, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,

(4, 1, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,

(2, 3, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,

(6, 7, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,

(2, 7, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,

(6, 3, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,

(0, 3, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,

(4, 7, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,

(0, 7, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,

(4, 3, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,

(2, 1, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1, 0) if the encoder is in state 5, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,

(3, 2,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

(7, 6,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110,

(7, 0,  $\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

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(6, 4,  $\pi$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_R$ ) equal 1111,

(1, 1,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 1,  $3\pi/2$ ) if the encoder is in state 5, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111.

41. The system of claim 35, wherein  
the encoder receives two state bits ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and  
the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:
- (0, 1, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,
  - (4, 5, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,
  - (0, 5, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,
  - (4, 1, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,
  - (2, 3, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,
  - (6, 7, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,
  - (2, 7, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,
  - (6, 3, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,
  - (0, 3, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,
  - (4, 7, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,
  - (0, 7, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,



(4, 3, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,

(2, 1, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1, 0) if the encoder is in state 6, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,

(3, 2,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

(7, 6,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110,

(7, 0,  $\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4,  $\pi$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 1,  $3\pi/2$ ) if the encoder is in state 6, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111.

42. The system of claim 35, wherein

the encoder receives two state bits ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and

the transmission variables ( $X_1$ ,  $X_2$ ,  $\Theta$ ) equal:

(0, 1, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,

(4, 5, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,

(0, 5, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,

(4, 1, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,

(2, 3, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,

(6, 7, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,

(2, 7, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,

(6, 3, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,

(0, 3, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,

(4, 7, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,

(0, 7, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,

(4, 3, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,

(2, 1, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1, 0) if the encoder is in state 7, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,

(3, 2,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

(7, 6,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110,

(7, 0,  $\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4,  $\pi$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 1,  $3\pi/2$ ) if the encoder is in state 7, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111.



43. The system of claim 35, wherein  
the encoder receives two state bits ( $B_A$ ) and four modulation bits ( $B_B$ ) at a time  $T_0$ , and  
the transmission variables ( $X_1, X_2, \Theta$ ) equal:
- (0, 1, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0000,
  - (4, 5, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0001,
  - (0, 5, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0010,
  - (4, 1, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0011,
  - (2, 3, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0100,
  - (6, 7, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0101,
  - (2, 7, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0110,
  - (6, 3, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 0111,
  - (0, 3, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1000,
  - (4, 7, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1001,
  - (0, 7, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1010,
  - (4, 3, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1011,
  - (2, 1, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1100,

(6, 5, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1101,

(2, 5, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1110,

(6, 1, 0) if the encoder is in state 8, the state bits ( $B_A$ ) equal 10, and the modulation bits ( $B_B$ ) equal 1111,

(1, 0,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0000,

(5, 4,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0001,

(1, 4,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0010,

(5, 0,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0011,

(3, 2,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0100,

(7, 6,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0101,

(3, 6,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0110,

(7, 2,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 0111,

(1, 2,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1000,

(5, 6,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1001,

(1, 6,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1010,

(5, 2,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1011,

(3, 0,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1100,

(7, 4,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1101,

(3, 4,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1110,

(7, 0,  $\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 11, and the modulation bits ( $B_B$ ) equal 1111,

(0, 0,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0000,

(4, 4,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0001,

(0, 4,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0010,

(4, 0,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0011,

(2, 2,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0100,

(6, 6,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0101,

(2, 6,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0110,

(6, 2,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 0111,

(0, 2,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1000,

(4, 6,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1001,

(0, 6,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1010,

(4, 2,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1011,

(2, 4,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1100,

(6, 0,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1101,

(2, 0,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1110,

(6, 4,  $\pi$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 00, and the modulation bits ( $B_B$ ) equal 1111,

(1, 1,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0000,

(5, 5,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0001,

(1, 5,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0010,

(5, 1,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0011,

(3, 3,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0100,

(7, 7,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0101,

(3, 7,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0110,

(7, 3,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 0111,

(1, 3,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1000,

(5, 7,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1001,

(1, 7,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1010,

(5, 3,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1011,

(3, 1,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1100,

(7, 5,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1101,

(3, 5,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1110, and

(7, 1,  $3\pi/2$ ) if the encoder is in state 8, the state bits ( $B_A$ ) equal 01, and the modulation bits ( $B_B$ ) equal 1111.

44. A telecommunications system, comprising:  
a receiver having a decoder that decodes a multi-state trellis code;  
and  
at least one receiver element coupled to the receiver,  
wherein, during operation, the decoder decodes received  
information signals encoded using at least two orthogonal space-time block codes  
of a form

$$C(x_1, x_2, \theta) = \begin{pmatrix} x_1 e^{j\theta} & x_2 \\ -x_2^* e^{j\theta} & x_1^* \end{pmatrix}.$$

45. A telecommunications system, comprising:  
a receiver having a decoder that decodes a multi-state trellis code;  
and  
at least one receiver element coupled to the receiver,

wherein, during operation, the decoder decodes received information signals encoded using at least two orthogonal space-time block codes of a form

$$C(x_1, x_2, \theta) = \begin{pmatrix} x_1 e^{j\theta} & x_2 e^{j\theta} \\ -x_2^* & x_1^* \end{pmatrix}.$$

46. The system of claim 44, wherein  
the at least one receiver element is an antenna.
47. The system of claim 44, wherein  
the at least one receiver element is an optical receiver.
48. A method for designing a full-diversity code, comprising the steps  
of:
- (1) selecting a rate for the diverse transmission scheme;
  - (2) selecting a number of states for the code;
  - (3) selecting a super-orthogonal space-time trellis structure  
having the number of states selected in step (2);
  - (4) selecting a super-orthogonal space-time set partitioning  
structure that corresponds to the rate selected in set (1); and
  - (5) assigning values to a set of transmission variable in  
accordance with the super-orthogonal space-time trellis structure selected in step  
(3) and the super-orthogonal space-time set partitioning structure selected in step  
(4).